# Regional San Monetized Benefits A.3
# Monetization Methods Public Benefits
# Section BCRM

## Table of Contents

## Summary of Results

| Section ID | Valued Benefit | Valuation Method | Net Present Value (2015 USD) | | Value used in Total NPV? |
|---|---|---|---|---|---|
| | | | 2030 Climate Scenario | 2070 Climate Scenario | |
| ***Ecosystem Improvements*** | | | | | |
| 1A | Additional Fall-run Chinook | Avoided Cost | | | n/a |
| 1B | | Alternative Cost | $69,384,434 | $55,032,615 | Y |
| 1C | | WTP | $81,686,831 | $54,267,475 | N |
| 2A | Improved Wetland Habitat | Avoided Cost | | | n/a |
| 2B | | Alternative Cost | $113,072,360 | $74,103,115 | Y |
| 2C | | WTP | $747,082,689 | $768,039,641 | N |
| 3A | Additional Riparian Habitat | Avoided Cost | | | n/a |
| 3B | | Alternative Cost | $31,023,586 | $31,023,586 | Y |
| 3C | | WTP | | | N |
| 4A | Greater Sandhill Crane Habitat | Avoided Cost | | | n/a |
| 4B | | Alternative Cost | | | n/a |
| 4C | | WTP | $179,558,434 | $179,558,434 | Y |
| 5A | Additional Vernal Pool Habitat | Avoided Cost | | | n/a |
| 5B | | Alternative Cost | $10,457,252 | $10,457,252 | Y |
| 5C | | WTP | | | n/a |
| ***Recreational Purposes*** | | | | | |
| 6A | Recreational Purposes | Avoided Cost | | | n/a |
| 6B | | Alternative Cost | | | n/a |
| 6C | | WTP | $9,485,088 | $7,608,544 | Y |
| ***Water Quality Improvement*** | | | | | |
| 7A | Water Quality Purposes | Avoided Cost | | | n/a |
| 7B | | Alternative Cost | $589,408,938 | $589,408,938 | Y |
| 7C | | WTP | | | n/a |
| **Total Net Present Value (Avoided Cost + Minimum of Alternative Cost & WTP)** | | | **$1,002,390,092** | **$947,147,484** | Y |

# 1. Ecosystem Improvement: Fall-Run Chinook

## 1A. Avoided Cost for Fall-Run Chinook Improvement

This method was not used. We could not identify any costs that would be avoided as a result of increasing fall-run Chinook in the Cosumnes River. For example, we could not identify any recovery plans (and cost estimates) associated with fall-run Chinook in the specified region.

## 1B. Alternative Cost for Fall-Run Chinook Improvement

**Benefit Type**

Public

**Benefit Category**

Ecosystem improvements

**Physical Benefit**

Salmon & Steelhead Escapement (fall-run Chinook salmon)

**Physical Benefit (detail)**

Physical benefits are defined as the "positive or beneficial physical changes" associated with a project or action.[i] The action considered here is the delivery of recycled water to agricultural areas for in-lieu groundwater recharge and water supply, which will in turn support increased stream flows and water surface elevation during key ecological periods, such as fall and spring migration. Improved flows during these essential time periods will improve conditions for fall-run Chinook salmon, allowing them to migrate to upstream spawning reaches. This action will be one component of The South County Ag Program.

The physical benefit of this action, monetized in this section, is increased in-stream flow (which supports fall-run Chinook salmon). Care has been taken to ensure that valuing stream flow would not double count other benefits valued in later sections.

As described in the Physical Benefits attachment, in-stream flow in the with-project and without-project 2030 and 2070 future conditions were compared. As described in the Physical Benefits attachment, in-stream flow in the Cosumnes is expected to increase by approximately 12,000 to 15,000 acre-feet per year in the with-project condition relative to the without-project condition depending on the climate scenario. The actual change in flow varies according to hydrologic year.

**Applicable Ecosystem Priorities**

- P8 - Maintain or restore groundwater and surface water interconnection to support instream benefits and groundwater dependent ecosystems.

- P9 - Enhance flow regimes or groundwater conditions to improve the quantity and quality of riparian and floodplain habitats for aquatic and terrestrial species.

- P11 - Enhance the temporal and spatial distribution and diversity of habitats to support all life stages of fish and wildlife species.

- P16 - Enhance habitat for native species that have commercial, recreational, scientific, or educational uses.

**Monetization Method**

Alternative Cost

**Discount Rate**

3.5%

**Planning Horizon**

84 years

**Monetization Method (detail)**

To estimate the alternative cost of improving salmon populations, we estimate the costs associated with purchasing the additional river flow required to sustain the improved population. We chose to value this additional water flow provided by the project using the unit values recommended in the Technical Reference. These values were for the Sacramento Valley, which ranged from $145 per acre foot in wet years to $345 per acre foot in critical years.

**Monetization Results**

The worksheet “1B. Fall run Chinook (Alt C)” in Attachment 6 shows the number of acre-feet of additional water flow provided at each year of the project, as well as the type of water year (wet to critical). Alternative costs are expressed in present ($2015) dollars, and differed by water year. The alternative cost was applied to the increased volume in each year, according to the type of water year. A 3.5% discount rate is used to estimate the present value of future years. Table 1 shows the first 10 years of the alternative cost calculation for the 2030 scenario as an example (note Attachment 6 includes the full 84 years).

**Table 1. Alternative cost example for fall-run chinook**

| Project Year | Water Year | Water Year Type | 2030 Scenario Increased Volume (Acre-Feet/Year) | Alternative Cost ($ per Acre Foot) | Alternative Cost ($ per Year) | Present Value of Alternative Cost ($ per year) |
|---|---|---|---|---|---|---|
| 1 | 1970 | Above Normal | 98 | $ 191 | $18,650 | $18,020 |
| 2 | 1971 | Wet | 3,201 | $ 145 | $464,126 | $433,266 |
| 3 | 1972 | Above Normal | 6,522 | $ 191 | $1,245,647 | $1,123,502 |
| 4 | 1973 | Wet | 7,795 | $ 145 | $1,130,301 | $984,992 |
| 5 | 1974 | Wet | 12,345 | $ 145 | $1,789,988 | $1,507,122 |
| 6 | 1975 | Wet | 13,106 | $ 145 | $1,900,310 | $1,545,903 |
| 7 | 1976 | Critical | 13,768 | $ 345 | $4,749,832 | $3,733,325 |
| 8 | 1977 | Dry | 6,117 | $ 275 | $1,682,264 | $1,277,530 |
| 9 | 1978 | Wet | 2,209 | $ 145 | $320,367 | $235,063 |
| 10 | 1979 | Wet | 14,428 | $ 145 | $2,092,090 | $1,483,122 |

**Net Present Value of Benefits**

- 2030 Climate Scenario: $69,384,434
- 2070 Climate Scenario: $55,032,615

## 1C. Willingness to Pay for Fall-Run Chinook Improvement

**Benefit Type**

Public

**Benefit Category**

Ecosystem improvements

**Physical Benefit**
Salmon & Steelhead Escapement (fall-run Chinook salmon)

**Physical Benefit (detail)**
Physical benefits are defined as the "positive or beneficial physical changes" associated with a project or action.[ii] The action considered here is the delivery of recycled water to agricultural areas for in-lieu groundwater recharge and water supply, which will in turn support increased stream flows and water surface elevation during key ecological periods, such as fall and spring migration. Improved flows during these essential time periods will improve conditions for fall-run Chinook salmon, allowing them to migrate to upstream spawning reaches. The physical benefit of this action, monetized in this section, is increased escapement of fall-run Chinook salmon. This action will be one component of South County Ag Program.

As described in the Physical Benefits attachment, the fall-run Chinook salmon in the with-project and without-project future conditions were compared. We assumed that the number of escaping fall-run Chinook would not change in the without-project condition. As described in the Physical Benefits attachment, the number of escaping fall-run Chinook is expected to increase by approximately 143 individuals in the with-project condition relative to the without-project condition in the 2030 climate scenario, and by 95 individuals in the 2070 climate scenario. The population increase is estimated to take approximately 10 years in both climate scenarios, and remain constant through Year 100.

**Applicable Ecosystem Priorities**

- P8 - Maintain or restore groundwater and surface water interconnection to support instream benefits and groundwater dependent ecosystems.
- P9 - Enhance flow regimes or groundwater conditions to improve the quantity and quality of riparian and floodplain habitats for aquatic and terrestrial species.
- P11 - Enhance the temporal and spatial distribution and diversity of habitats to support all life stages of fish and wildlife species.
- P16 - Enhance habitat for native species that have commercial, recreational, scientific, or educational uses.

**Monetization Method**
Willingness-to-Pay

**Discount Rate**
3.5%

**Planning Horizon**

84 years

**Monetization Method (detail)**

The guidance in the Technical Reference recommends a study by Layton et al. (1999) to value increases in salmon population. The study conducts a contingent valuation survey evaluating willingness-to-pay for increased fish populations.[iii] We use the function transfer method to calculate an appropriate willingness-to-pay value per fish. The most appropriate model to use from Layton et al. (1999) is the model for Eastern Washington and Columbia River Migratory Fish (CM). Other models are specific to freshwater fish or saltwater fish, not anadromous fish such as salmon. Another model, for Western Washington and Puget Sound Migratory Fish (PM), also looks at anadromous fish. We didn't consider the use of the PM model, because the location of the CM model fits our study area more closely. Furthermore, the populations considered in the CM model are much smaller than those of the PM model; and the salmon population in the Cosumnes River is also smaller in scale. We also chose the logarithmic model using percentage of population increases, as it performed better than other model specifications. Finally, we chose to use the model identified as "Low Status Quo" as the population sizes assumed in this model are on par with those in California.

The estimated coefficients ($\beta$) for the CM log model are:

- Cost: -0.0207
- Population Increase (Percent): 0.1003

WTP is calculated as

$$WTP = \frac{\beta_{fish}(0 - \ln(fish\%))}{\beta_{cost}}$$

We calculated the WTP using the smallest possible percentage change the model would allow (5%). This corresponds to a salmon population increase of 25,000 fish. Although this is still quite high compared to the increases assumed to occur due to our project, it is the smallest increase acceptable within the model.

The WTP calculated by this model is in units of households per month. We inflated this value to 2015 USD, and multiplied by 12 to arrive at a WTP value of $133 per household per year. The survey questionnaire states that payments would be made over 20 years; the present value of which at a 3.5% discount rate is $1,889. If this amount were to be paid over 100 years instead, the value would be $68 per household per year. We multiply this value by the number of

California households (approximately 15 million) and the response rate of the study (68%) and divide by population increase to arrive at a WTP value of $27,863 per fish.

Our WTP-per-fish value is then applied to the increased fish population in each year of the project. The Net Present Value of this benefit is calculated over a planning horizon of 84 years with a discount rate of 3.5%.

**Monetization Results**

As described in the Physical Benefits attachment, it was estimated that in the with-project conditions, the number of escaping fall-run Chinook salmon would increase. In the 2030 climate scenario, this increase is estimated to reach 143 additional fall-run Chinook each year. For the 2070 climate scenario, this total is 95 fish per year. However, this increase does not occur immediately. Fall-run chinook populations are not expected to begin increasing until year 7 of the project, reaching the full amount by year 10. When the population increase reaches its maximum, the total annual WTP benefits are $4 million for the 2030 scenario, and $2.7 million for the 2070 scenario. Table 2 shows an example calculation for the first ten years of the project.

**Table 2. WTP Calculation Example for Fall-Run Chinook**

| Project Year | 2030 Scenario Additional Fall Chinook | Total WTP/Y | PV |
|---|---|---|---|
| 1 | 0 | $0 | $0 |
| 2 | 0 | $0 | $0 |
| 3 | 0 | $0 | $0 |
| 4 | 0 | $0 | $0 |
| 5 | 0 | $0 | $0 |
| 6 | 0 | $0 | $0 |
| 7 | 35.75 | $996,088 | $782,916 |
| 8 | 71.5 | $1,992,176 | $1,512,882 |
| 9 | 107.25 | $2,988,265 | $2,192,582 |
| 10 | 143 | $3,984,353 | $2,824,583 |

**Net Present Value of Benefits**

- 2030 Climate Scenario: $81,686,831

- 2070 Climate Scenario: $54,267,475

**Assumptions and Limitations**

- We made the assumption that the models in Layton et al. (1999) are a good fit for our study area. Perhaps the largest limitation to this value is a discrepancy in population sizes. The population of fall Chinook which use the Cosumnes is quite small, compared to the scale of other literature. None of the WTP studies reviewed in the Technical Reference ask survey respondents to value small population increases, such is the case for this project. However, this study provides the closest population match to California. Furthermore, values would be expected to increase for smaller population sizes due to scarcity, so the use of this model could be viewed as a conservative estimate. Finally, our project is expected to result in an increase to native salmon, not those raised by hatchery, which would likely further increase their WTP values, further demonstrating that this is a conservative value.

- As recommended in the Technical Reference, all factors influencing benefits after 2070 were held constant, including the population increase in fall run Chinook. This partially mitigates the uncertainty of estimates so far in the future.

# 2. Ecosystem Improvement: Wetland Habitat

## 2A. Avoided Cost for Wetland Habitat Improvement

This method was not used. We could not identify any costs that would be avoided as a result of wetland habitat improvement. This is because there is no clear means by which an action could be avoided that would then provide an equivalent ecosystem service in that location.

## 2B. Alternative Cost for Wetland Habitat Improvement

**Benefit Type**

Public

**Benefit Category**

Ecosystem improvements

**Physical Benefit**

Wetland habitat restoration

**Physical Benefit (detail)**

Physical benefits are defined as the "positive or beneficial physical changes" associated with a project or action (California Code of Regulations, 2016). The physical benefit monetized in this section is the enhancement of approximately 3,800-4,400 acres of wetland habitat (depending on the climate scenario), as described in the Ecological Plan. This action will be one component of The South County Ag Program.

**Applicable Ecosystem Priorities**

- P 8. Maintain or restore groundwater and surface water interconnection to support instream benefits and groundwater dependent ecosystems.

- P 11. Enhance the temporal and spatial distribution and diversity of habitats to support all life stages of fish and wildlife species.

- P 14. Provide water to enhance seasonal wetlands, permanent wetlands, and riparian habitat for aquatic and terrestrial species on State and Federal wildlife refuges and on other public and private lands.

- P 15. Develop and implement invasive species management plans utilizing techniques that are supported by best available science to enhance habitat and increase the survival of native species.

- P 16. Enhance habitat for native species that have commercial, recreational, scientific, or educational uses.

**Monetization Method**

Alternative Cost (cost of the alternative to provide the wetland habitat)

**Discount Rate**

3.5%

**Planning Horizon**

84 years

**Monetization Method (detail)**

It was assumed that the most feasible alternative available to the State of California to restore wetland habitat would be to either 1) restore the habitat itself; or 2) purchase mitigation bank credits for wetland habitat from third party conservation banks. For the purposes of this valuation, we used the mitigation bank approach.

A wetlands mitigation bank is defined by the Environmental Protection Agency as "…a wetland area that has been restored, established, enhanced or preserved, which is then set aside to compensate for future conversions of wetlands for development activities."[1] Wetland bank credits represent protection and restoration of wetland habitats, which can be sold by wetland bank owners to offset unavoidable adverse impacts that developers or others have through their projects in other locations.[2] Conservation and mitigation banks in California are established and approved by the California Department of Fish and Wildlife.

We contacted two organizations that own/operate wetland mitigation banks, and one organization that operates an in-lieu fee program, for wetlands in Sacramento County and the surrounding region. These organizations were able to provide us with the pricing range for wetland mitigation credits in the Sacramento County region. The price of one credit represents the costs associated with acquisition, restoration, project management, and ongoing project stewardship (maintenance & monitoring) for one acre of wetlands. The cost of a credit can vary according to mitigation bank location, scarcity of credits, and other factors. We requested a range and took the average per-acre cost reported from the three sources ($158,333 per acre). Table 3 summarizes this information.

[1] https://www.epa.gov/sites/production/files/2015-08/documents/compensatory_mitigation_factsheet.pdf

[2] https://www.fws.gov/endangered/esa-library/pdf/conservation_banking.pdf

**Table 3. Wetland Mitigation Bank Credit Cost Ranges**

| Organization | Price per Credit | | Source |
|---|---|---|---|
| | Low | High | |
| Westervelt Environmental Services | $130,000 | $145,000 | Personal communication with Travis Hemmen |
| Wildlands, Inc. | $125,000 | $250,000 | Personal communication with Julie Maddox |
| National Fish and Wildlife Foundation | $150,000 | $150,000 | Online report |
| **Average (2017 USD)** | **$158,333** | | |
| **Average (2015 USD)** | **$152,378** | | |

As described in the Ecological Plan, approximately 3,800-4,400 acres of wetlands are expected to be enhanced, depending on the climate scenario (2030 or 2070). However, not all acres of wetlands will be enhanced by the same amount. The six major categories of enhancement are:

1. Acres on managed lands beginning at 85% functionality and increasing to 95% functionality due to groundwater improvements

2. Acres on managed lands beginning at 85% functionality and increasing to 90% functionality due to groundwater improvements

3. Acres on unmanaged lands beginning at an unknown functionality but increasing by 25% in overall functionality due to groundwater improvements

4. Acres on unmanaged lands beginning at an unknown functionality but increasing by 50% in overall functionality due to groundwater improvements

5. Acres on unmanaged lands beginning at an unknown functionality but increasing by 50% in overall functionality due to water application and management

6. Acres on managed lands beginning at an unknown functionality but increasing by 10% in overall functionality due to water application and management

**Because wetland mitigation credits represent acres that have increased significantly in functionality (e.g. as much as 0-100% if a new wetland acre is being created), using the full value of a wetland credit may result in an overestimate for the actual cost of increasing the functionality of a wetland acre by a smaller number such as 5%. Therefore, the value of each acre was weighted according to the level of enhancement it is projected to attain.**

Table 4 demonstrates how wetland values were weighted according to increase in functionality.

**Table 4. Cost of wetland enhancement by increase in functionality**

| Increase in Wetland Function | Value |
|---|---|
| 100% | $152,378 |
| 50% | $76,189 |
| 25% | $38,095 |
| 10% | $15,238 |
| 5% | $7,619 |

This approach is of course not ideal, because it is uncommon for wetland acres to be targeted for enhancement of only 5-10%. If this did happen, the cost of enhancement may not be linearly related to the amount of enhancement (e.g. increasing functionality by 5% may not cost 5% of increasing functionality by 100%). However, this approach was considered a suitable and transparent approximation of alternative costs associated with enhancement.

The alternative costs of achieving the same outcome through mitigation bank credit purchases were estimated over the project horizon of 84 years. According to the Ecological Plan, the wetlands will be enhanced gradually between Years 1 and 10 of the project. Therefore, the alternative costs were adjusted in proportion to the number of acres restored in any given year and discounted appropriately.

**Monetization Results**

The worksheet “2B. Wetland Habitat (Alt C)” in Attachment 6 shows the number of acres of wetland habitat enhanced at each year of the project (and level of enhancement), and links these areas to alternative cost estimates at each year. Alternative costs are expressed in 2015 USD. A 3.5% discount rate is used to estimate the present value of future years. Table 5 shows the first 15 years of the alternative cost calculation in four of the categories of wetlands as an example (note Attachment 6 includes the full 84 years). Note that the enhancement of each acre was only counted once over the project horizon, since a wetland mitigation credit represents an improvement in perpetuity.

**Table 5. Alternative Costs of Wetland Enhancement**

| **2030 Scenario** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Project Year** | **Existing Ac.going from 85%95% function** | **Additional Ac. vs. Previous Year** | **PV** | **Existing Ac.going from 85%90% function** | **Additional Acres vs. Previous Year** | **PV** | **Existing Ac. with a 25% increase in function** | **Additional Ac. vs. Previous Year** | **PV** | **Existing Ac. with a 50% increase in function** | **Additional Ac. vs. Previous Year** | **PV** |
| 1 | - | | $0 | - | - | $0 | - | | $0 | - | | $0 |
| 2 | - | - | $0 | - | - | $0 | - | | $0 | - | | $0 |
| 3 | - | - | $0 | - | - | $0 | - | | $0 | - | | $0 |
| 4 | - | - | $0 | - | - | $0 | - | | $0 | - | | $0 |
| 5 | - | - | $0 | - | - | $0 | - | | $0 | - | | $0 |
| 6 | - | - | $0 | - | - | $0 | - | | $0 | - | | $0 |
| 7 | 216 | 216 | $2,589,984 | 90 | 90 | $540,453 | 323 | 323 | $9,663,785 | 168 | 168 | $10,03 |
| 8 | 433 | 216 | $2,502,400 | 181 | 90 | $522,177 | 646 | 323 | $9,336,991 | 335 | 168 | $9,691 |
| 9 | 649 | 216 | $2,417,778 | 271 | 90 | $504,519 | 968 | 323 | $9,021,247 | 503 | 168 | $9,363 |
| 10 | 865 | 216 | $2,336,017 | 361 | 90 | $487,458 | 1,291 | 323 | $8,716,181 | 670 | 168 | $9,047 |
| 11 | 865 | - | $0 | 361 | - | $0 | 1,291 | - | $0 | 670 | - | $0 |
| Etc.to 84 | | | | | | | | | | | | |
| | | | | | | | | | | | | |

**Net Present Value of Benefits**

- 2030 climate scenario: $113,072,360
- 2070 climate scenario: $74,103,115

**Assumptions and Limitations:**

- It is assumed that a feasible and reasonable alternative to the state for wetland habitat restoration is the purchase of wetland mitigation bank credits.

## 2C. Willingness to Pay for Wetland Habitat Improvement

**Benefit Type**

Public

**Benefit Category**

Ecosystem improvements

**Physical Benefit**

Wetlands improved

**Physical Benefit (detail)**

Physical benefits are defined as the "positive or beneficial physical changes" associated with a project or action.[ii] The physical benefit monetized in this section is the enhancement of up to 3,800-4,400 acres of wetland habitat, as described in the Ecological Plan. This action will be one component of South County Ag Program.

**Applicable Ecosystem Priorities**

- P9 - Enhance flow regimes or groundwater conditions to improve the quantity and quality of riparian and floodplain habitats for aquatic and terrestrial species.
- P11 - Enhance the temporal and spatial distribution and diversity of habitats to support all life stages of fish and wildlife species.
- P14 - Provide water to enhance seasonal wetlands, permanent wetlands, and riparian habitat for aquatic and terrestrial species on State and Federal wildlife refuges and on other public and private lands.
- P16 - Enhance habitat for native species that have commercial, recreational, scientific, or educational uses.

**Monetization Method**

Willingness-to-Pay

**Discount Rate**

3.5%

**Planning Horizon**

84 years

**Monetization Method (detail)**

We used the benefit transfer method to estimate Californians' willingness-to-pay (WTP) to improve wetland function. A study by Hanemann et al. (1991) was selected as the most appropriate model to represent Californians' WTP for wetland habitat.[iv] Hanemann et al. use the contingent valuation method to estimate Californians' WTP for several environmental improvement programs in the San Joaquin River Valley, including wetland habitat improvement above current levels. In the survey, respondents are asked their WTP for a "…wetlands program would go beyond maintenance to improve wetland habitat above current levels." Though it is not specified in the study, our research suggests that approximately 90,000 acres of wetlands existed in the San Joaquin Valley at the time of the survey,[v] so we assume the WTP applied to that entire area.

Survey results in the study showed a WTP estimate of $251 per household per year for wetland improvement on the low end of the range (in 1991 USD). According to the State of California, the number of households in the year of the study were 11,182,513.[vi] We discounted this total by the survey response rate, 63.1%, and multiplied the number by $251 per household to find a total annual WTP of approximately $1.8 billion annually. Across 90,000 acres, this WTP is approximately $19 thousand per acre per year. Inflated to 2015 USD, this represents a WTP of $36,000 per acre per year. Although it was not specified in the Hanemann survey, in order to be conservative, we assume that this WTP is for a 100% increase in wetland function across all acres of wetlands. So, for example, if one acre of wetlands was at 25% function, Californians' WTP would be related to bringing its function up to 50%, and so forth.

As described in the Ecological Plan, approximately 3,800-4,400 acres of wetlands are expected to be enhanced, depending on the climate scenario (2030 or 2070). However, not all acres of wetlands will be enhanced by the same amount. The six major categories of enhancement are:

1. Acres on managed lands beginning at 85% functionality and increasing to 95% functionality due to groundwater improvements
2. Acres on managed lands beginning at 85% functionality and increasing to 90% functionality due to groundwater improvements

3. Acres on unmanaged lands beginning at an unknown functionality but increasing by 25% in overall functionality due to groundwater improvements

4. Acres on unmanaged lands beginning at an unknown functionality but increasing by 50% in overall functionality due to groundwater improvements

5. Acres on unmanaged lands beginning at an unknown functionality but increasing by 50% in overall functionality due to water application and management

6. Acres on managed lands beginning at an unknown functionality but increasing by 10% in overall functionality due to water application and management

To provide a conservative benefit estimate for the project, we applied the WTP calculated above according to the increase in function of each wetland acre as a result of the South County Ag Program. For example, we assumed a 10% increase in function resulted in 10% of the WTP benefit (i.e. $3,600 per acre per year). Thus, a wetland acre that increases from 85% to 90% function has experience a (5/85*100 =) 5.88% increase in function, and would have a WTP value of (5.88% * $3,600 =) $2,123 per acre per year. This approach was applied across all acres of wetlands that will see improvement as a result of the South County Ag Program, with a project horizon of 84 years, for both the 2030 and 2070 climate change scenarios. A 3.5% discount rate was applied to future benefits, and the Net Present Value of all future benefits was summed.

**Net Present Value of Benefits**

- 2030 climate scenario: $747,082,689 over 84 years.
- 2070 climate scenario: $768,039,641 over 84 years.

**Assumptions and Limitations**

- As recommended in the Technical Reference, all factors influencing benefits after 2070 were held constant. This includes household estimates as well as the WTP values. This partially mitigates the uncertainty of estimates so far in the future.
- The levels of habitat improvement in Hanemann et al. 1991 is unstated. The ecological state or health of these wetlands is also unknown. Therefore, we assumed this increase in function would equal 100%. This assumption allows conservative estimates of WTP for improved wetlands, as the values per acre derived from Hanemann et al. are quite high. Despite the age of the study, we feel these precautions—along with the similarity in study sites and resource valued—provide a reasonable measure of the WTP for this benefit.

# 3. Ecosystem Improvement: Riparian Habitat Improvement

## 3A. Avoided Cost for Riparian Habitat Improvement

This method was not used. We could not identify any costs that would be avoided as a result of riparian habitat improvement. This is because there is no clear means by which an action could be avoided that would then provide an equivalent ecosystem service in that location.

## 3B. Alternative Cost for Riparian Habitat Improvement

**Benefit Type**

Public

**Benefit Category**

Ecosystem improvements

**Physical Benefit**

Additional Riparian Habitat

**Physical Benefit (detail)**

Physical benefits are defined as the "positive or beneficial physical changes" associated with a project or action (California Code of Regulations, 2016). The physical benefit monetized in this section is the restoration of approximately 500 acres of riparian habitat, as described in the Ecological Plan. This action will be one component of South County Ag Program.

**Applicable Ecosystem Priorities**

- P 8. Maintain or restore groundwater and surface water interconnection to support instream benefits and groundwater dependent ecosystems.
- P 11. Enhance the temporal and spatial distribution and diversity of habitats to support all life stages of fish and wildlife species.
- P 14. Provide water to enhance seasonal wetlands, permanent wetlands, and riparian habitat for aquatic and terrestrial species on State and Federal wildlife refuges and on other public and private lands.
- P 15. Develop and implement invasive species management plans utilizing techniques that are supported by best available science to enhance habitat and increase the survival of native species.
- P 16. Enhance habitat for native species that have commercial, recreational, scientific, or educational uses.

**Monetization Method**
Alternative Cost (cost of the alternative to provide the riparian habitat)

**Discount Rate**
3.5%

**Planning Horizon**
84 years

**Monetization Method (detail)**
It was assumed that the most feasible alternative available to the State of California to restore riparian habitat would be to either 1) restore the habitat itself; or 2) purchase conservation bank credits for riparian habitat from third party conservation banks. For the purposes of this valuation, we used the conservation bank approach.

Conservation banks are defined by the U.S. Fish and Wildlife Service as "…lands are conserved and permanently managed for species that are endangered, threatened, candidates for listing as endangered or threatened, or are otherwise species-at-risk." Conservation bank credits represent protection of certain habitats or species, such as riparian habitat, which can be sold by conservation bank owners to offset unavoidable adverse impacts that developers or others have through their projects in other locations.[3] Conservation and mitigation banks in California are established and approved by the California Department of Fish and Wildlife.

We contacted two organizations that own/operate conservation banks for riparian habitat in Sacramento County and the surrounding region. These organizations were able to provide us with the pricing range for riparian habitat mitigation credits in the Sacramento County region. The price of one credit represents the costs associated with acquisition, restoration, project management, and ongoing project stewardship (maintenance & monitoring) for one acre of riparian habitat. The cost of a credit can vary according to mitigation bank location, scarcity of credits, and other factors. We requested a range of estimates (high and low) from each source, and took the average per-acre cost reported from the two sources ($91,250 per acre).

Table 6 summarizes this information. Since these conversations took place in 2017, we assumed these values were being reported in 2017 USD, so this value was adjusted to the 2015 USD value of $87,818 per acre.

[3] https://www.fws.gov/endangered/esa-library/pdf/conservation_banking.pdf

**Table 6. Riparian Habitat Conservation Bank Credit Cost Estimates**

| Organization | Price per Credit | | Source |
|---|---|---|---|
| | Low | High | |
| Westervelt Environmental Services | $75,000 | $85,000 | Personal communication with Travis Hemmen |
| Wildlands, Inc. | $80,000 | $125,000 | Personal communication with Julie Maddox |
| **Average (2017 USD)** | $91,250 | | |
| **Average (2015 USD)** | $87,818 | | |

As described in the Ecological Plan, approximately 500 acres will be targeted for riparian habitat restoration in both the 2030 and 2070 climate scenarios. The alternative costs of restoring 500 acres through conservation bank credit purchases were estimated over the project horizon of 84 years. Because each credit is a one-time cost, only 500 credits were counted over the project horizon. According to the Ecological Plan, the 500 acres will be restored gradually between Years 1 and 15 of the project. Therefore, the alternative costs were adjusted in proportion to the number of acres restored in any given year and discounted appropriately.

**Monetization Results**

The worksheet "3B. Riparian Habitat (Alt C)" in Attachment 6 shows the number of acres of riparian habitat restored at each year of the project, and links these areas to alternative cost estimates at each year. Alternative costs are expressed in present ($2015) dollars. A 3.5% discount rate is used to estimate the present value of future years. Table 7 shows the first 15 years of the alternative cost calculation as an example (note Attachment 6 includes the full 84 years).

**Table 7. Alternative Costs of Riparian Habitat Restoration**

| | 2030 Climate Scenario | | | | |
|---|---|---|---|---|---|
| Year | Restored FORESTED riparian habitat (acres now at 95% function) | Additional Riparian Acres vs. Previous Year | Alternative Cost ($ per acre) | Total Alternative Costs by Year (undiscounted) | Total Alternative Costs by Year (discounted at 3.5%) |
| 1 | 0 | 0 | $87,818 | $0 | $0 |
| 2 | 0 | 0 | $87,818 | $0 | $0 |
| 3 | 10 | 10 | $87,818 | $878,181 | $792,069 |
| 4 | 25 | 15 | $87,818 | $1,317,271 | $1,147,926 |
| 5 | 50 | 25 | $87,818 | $2,195,452 | $1,848,512 |
| 6 | 75 | 25 | $87,818 | $2,195,452 | $1,786,002 |
| 7 | 100 | 25 | $87,818 | $2,195,452 | $1,725,606 |
| 8 | 150 | 50 | $87,818 | $4,390,904 | $3,334,504 |
| 9 | 200 | 50 | $87,818 | $4,390,904 | $3,221,743 |
| 10 | 250 | 50 | $87,818 | $4,390,904 | $3,112,795 |
| 11 | 300 | 50 | $87,818 | $4,390,904 | $3,007,531 |
| 12 | 350 | 50 | $87,818 | $4,390,904 | $2,905,827 |
| 13 | 400 | 50 | $87,818 | $4,390,904 | $2,807,562 |
| 14 | 450 | 50 | $87,818 | $4,390,904 | $2,712,621 |
| 15 | 500 | 50 | $87,818 | $4,390,904 | $2,620,890 |
| Etc. | | | | | |

### Net Present Value of Benefits

- 2030 climate scenario: $31,023,586
- 2070 climate scenario: $31,023,586

### Assumptions and Limitations

- It is assumed that a feasible and reasonable alternative to the state for riparian habitat restoration is the purchase of conservation bank credits for riparian habitats.

## 3C. Willingness to Pay for Riparian Habitat Improvement

This method was not used. The initial assessment of willingness to pay provided benefit values greater than an order of magnitude from the alternate cost. While banks are used to supply riparian benefits in the local area, they would not have the same ecological connectivity or patch size values. However, alternative costs are considerable less expensive and the other benefits of connectivity and patch size are not economically quantifiable.

# 4. Ecosystem Improvement: Greater Sandhill Crane

## 4A. Avoided Cost for Greater Sandhill Crane

This method was not used. We could not identify any costs that would be avoided as a result of Greater Sandhill Crane habitat or population improvements. The Technical Reference states that "An ecosystem improvement could contribute to recovery of a special-status species. If a project would allow costs of other improvements for special-status species to be reduced, the costs of these improvements might provide a basis for avoided cost estimates." However, we could not find any Greater Sandhill Crane recovery plans (with associated costs) for the State of California.

## 4B. Alternative Cost for Greater Sandhill Crane

This method was not used. The crane's winter roosting site fidelity does not allow the substitution of habitat in other locations.[vii] Ivey et al (2015) showed that within the project region, the foraging flight range was 1.9 km (+/- 0.01). One of the key features of this program's ecological benefits is the support of the existing crane management in this specific location, dictated by crane ecology. While alternate agricultural land and associated land practices is theoretically available, it simply would not be used by the crane and is not a functional alternative.

## 4C. Willingness to Pay for Greater Sandhill Crane

**Benefit Type**

Public

**Benefit Category**

Ecosystem improvements

**Physical Benefit**

Increased abundance of Greater Sandhill Cranes

**Physical Benefit (detail)**

Physical benefits are defined as the "positive or beneficial physical changes" associated with a project or action.[ii] The action considered here is the change in residue management on select farm fields, combined with wintertime field flooding, which will support essential habitat for the Greater Sandhill Cranes (*Grus canadensis tabida*). This action will be one component of South County Ag Program. The physical benefit of this action monetized in this section is an increased abundance of Greater Sandhill Cranes.

As described in the Physical Benefits attachment, the Greater Sandhill Crane Population in the with-project and without-project future conditions were compared. We assumed that the Greater Sandhill Crane population would not change in the without-project condition. To estimate the current population, we relied on a paper by Ivey et al. (2014).[viii] Ivey et al. (2014) estimates the current abundance of Greater Sandhill Cranes at five different roost complexes in the Sacramento-San Joaquin delta. These estimates range from 2,166 to 6,867 individuals among all roost complexes. As described in the Physical Benefits attachment, the population of Greater Sandhill Cranes is expected to increase by approximately 700 individuals in the with-project condition relative to the without-project condition. This translates to an 8.74% increase in population, if we assume the current population is at the high end of the estimates range (6,867). The increase by 700 individuals is estimated to be attained by Year 13.

**Applicable Ecosystem Priorities**

- P9. Enhance flow regimes or groundwater conditions to improve the quantity and quality of riparian and floodplain habitats for aquatic and terrestrial species.
- P11. Enhance the temporal and spatial distribution and diversity of habitats to support all life stages of fish and wildlife species.
- P14. Provide water to enhance seasonal wetlands, permanent wetlands, and riparian habitat for aquatic and terrestrial species on State and Federal wildlife refuges and on other public and private lands.
- P16. Enhance habitat for native species that have commercial, recreational, scientific, or educational uses.

**Monetization Method**

Willingness-to-Pay

**Monetization Method (detail)**

We used a benefit transfer method (function transfer) to estimate Californians' willingness-to-pay (WTP) to increase abundance of the Greater Sandhill Crane. Richardson and Loomis (2009) develop three models to calculate WTP through a meta-analysis of literature valuing people's WTP for rare, threatened, and endangered species.[ix] In addition, the models in the paper provides specific coefficients for birds, allowing us to target people's WTP for rare birds. The meta-analysis includes studies focused on the bald eagle, whooping crane, spotted owl, woodpecker, and turkey.

Richardson and Loomis (2009) updates models constructed in an older work by Loomis and White (1996).[ix] We estimate WTP for Greater Sandhill Cranes using one of double-log models, which is described in Table 7 of the paper. These models are detailed specifically for the purposes of benefit transfer. The chosen model provides the lowest estimate of WTP among the possible models, which we felt is a good conservative measure for estimating the benefits of our project. The model has the following variables and coefficients:

| Variable | Double-log model coefficients |
|---|---|
| Constant | 0.344 |
| LN CHANGESIZE | 0.953 |
| VISITOR | 1.299 |
| FISH | 0.678 |
| MARINE | 0.583 |
| BIRD | 0.555 |
| LN RESPONSERATE | -0.459 |
| CONJOINT | 2.620 |
| MAIL | -0.798 |
| CHARISMATIC | 0.765 |
| NEWSTUDY | 0.816 |
| STUDYYEAR | |

We used the following as inputs into the double log models:

| Variable | Description of variable | Input used |
|---|---|---|
| Constant | | N/A |
| LN CHANGESIZE | Percentage change in the species population | Natural log of the percent change in Greater Sandhill Crane population due to project |
| VISITOR | Dummy variable for whether or not respondents were visitors | Sample mean |
| FISH | Dummy variable for species group being valued | 0 |
| MARINE | Dummy variable for species group being valued | 0 |
| BIRD | Dummy variable for species group being valued | 1 |
| LN RESPONSERATE | Survey response rate | Sample mean |
| CONJOINT | Dummy variable for studies using conjoint analysis | Sample mean |
| MAIL | Dummy variable for mail surveys | Sample mean |
| CHARISMATIC | Dummy variable for ‘charismatic’ species | Sample mean |
| NEWSTUDY | Dummy variable for new studies that were not included in Loomis and White (1996) | Sample mean |
| STUDYYEAR | Year in which a study was performed | Sample mean |

**Monetization Results**

The double log models estimate WTP for the 8.74 percent increase in Greater Sandhill Cranes to be $5.15 (2006 USD per household per year). Adjusting for inflation, the WTP value is $6.11 per household per year.

The sample mean of the response rates in the meta-analysis is 49%. We adjusted the number of California households at each year in the analysis by this percentage. The number of households in California was adjusted over the project period according to projections from California Department of Finance.[x] Finally, we only applied the WTP value to the percentage of the California population who are active birdwatchers. According to a U.S. Fish and Wildlife Survey from 2011 on Birdwatching in the United States, approximately 16% of Californians actively engage in birdwatching.[xi] We assumed that only this portion of the population would have the WTP indicated in the model for threatened bird species such as the Greater Sandhill Crane. We believe this assumption results in a more conservative estimate.

We calculated the present value of this benefit over 84 years under two climate scenarios. The benefits for both scenarios were estimated to be equal.

**Net Present Value of Benefits**

- 2030 Climate Scenario: $179,558,434
- 2070 Climate Scenario: $179,558,434

**Assumptions and Limitations**

- We believe it is reasonable to apply this model to WTP for Greater Sandhill Crane populations with the benefit transfer method. The Greater Sandhill Cranes are listed as threatened in California,[xii] as with the other birds considered in the model. Furthermore, the model includes the whooping crane – another migrating crane species. The average of study's WTP for whooping cranes in the meta-analysis is $56 per household per year, which is the highest average annual WTP out of all the bird groups. We chose to use the models estimated rather than this average WTP as the original crane studies are more than twenty years old. Estimation year has been shown to have an effect on value estimates for ecosystem services.

- Furthermore, Richardson and Loomis (2009) determine that on average, the double log models have an average absolute percent error of 34 to 35 percent when used to predict willingness to pay values. This is a reasonable error, as some point-value transfer errors can range upwards of 100 percent error.[xiii] There is also some evidence that data from multiple studies improves function transfers.[xiv] This is another reason why we chose the use of this meta-analysis where no appropriate California studies could be found.

- Finally, as recommended in the Technical Reference, all factors influencing benefits after 2070 were held constant. This includes household estimates as well as the WTP values. This partially mitigates the uncertainty of estimates so far in the future.5. Ecosystem Improvement: Vernal Pool Habitat

## 5A. Avoided Cost for Vernal Pool Habitat Improvement

This method was not used. We could not identify any local or regional costs that would be avoided as a result of vernal pool habitat improvement. This is because there is no clear means by which an action could be avoided that would then provide an equivalent ecosystem service in that location.

## 5B. Alternative Cost for Vernal Pool Habitat Improvement

**Benefit Type**

Public

**Benefit Category**

Ecosystem improvements

**Physical Benefit**

Vernal pool habitat restoration and conservation

**Physical Benefit (detail)**

Physical benefits are defined as the "positive or beneficial physical changes" associated with a project or action (California Code of Regulations, 2016). The physical benefit monetized in this section is the restoration and conservation of approximately 500 acres of vernal pool complex habitat (or 50 "wetted" acres – see below for more detail), as described in the Ecological Plan. This action will be one component of South County Ag Program.

**Applicable Ecosystem Priorities**

- P 8. Maintain or restore groundwater and surface water interconnection to support instream benefits and groundwater dependent ecosystems.

- P 11. Enhance the temporal and spatial distribution and diversity of habitats to support all life stages of fish and wildlife species.

- P 14. Provide water to enhance seasonal wetlands, permanent wetlands, and riparian habitat for aquatic and terrestrial species on State and Federal wildlife refuges and on other public and private lands.

- P 15. Develop and implement invasive species management plans utilizing techniques that are supported by best available science to enhance habitat and increase the survival of native species.

- P 16. Enhance habitat for native species that have commercial, recreational, scientific, or educational uses.

**Monetization Method**

Alternative Cost (cost of the alternative to provide the vernal pool habitat).

**Discount Rate**

3.5%

**Planning Horizon**

84 years

**Monetization Method (detail)**

It was assumed that the most feasible alternative available to the State of California to restore vernal pool habitat would be to either 1) restore the habitat directly; or 2) purchase conservation bank credits for vernal pool habitat from third party conservation banks. For the purposes of this valuation, and because there is an active market for vernal pool credits, we used the second approach.

Conservation banks are defined by the U.S. Fish and Wildlife Service as "…lands are conserved and permanently managed for species that are endangered, threatened, candidates for listing as endangered or threatened, or are otherwise species-at-risk." Conservation bank credits represent protection of certain habitats or species, such as vernal pool habitat, which can be sold by conservation bank owners to offset unavoidable adverse impacts that developers or others have through their projects in other locations.[4] Conservation and mitigation banks in California are established and approved by the California Department of Fish and Wildlife.

We contacted two organizations that own/operate conservation banks, and one organization that runs an in-lieu fee program, for vernal pool habitat in Sacramento County and the surrounding region. These organizations were able to provide us with the pricing range for vernal pool habitat mitigation credits in the Sacramento County region. The price of one credit represents the costs associated with acquisition, restoration, project management, and ongoing project stewardship (maintenance & monitoring) for one acre of vernal pool habitat. The cost of a credit can vary according to mitigation bank location, scarcity of credits, and other factors. In order to be conservative we requested a range and took the average per-acre cost reported from the three sources of $275,833 per acre. Since these conversations took place in 2017, we

[4] https://www.fws.gov/endangered/esa-library/pdf/conservation_banking.pdf

assumed these values were being reported in 2017 USD, so this value was adjusted to the 2015 USD value of $265,459 per acre. Table 8 summarizes this information.

**Table 8. Vernal Pool Conservation Bank Credit Cost**

| Organization | Price per Credit | | Source |
|---|---|---|---|
| | Low | High | |
| Westervelt Environmental Services | $250,000 | $275,000 | Personal communication with Travis Hemmen |
| Wildlands, Inc. | $275,000 | $325,000 | Personal communication with Julie Maddox |
| National Fish and Wildlife Foundation | $265,000 | $265,000 | Online report |
| **Average (2017 USD)** | **$275,833** | | |
| **Average (2015 USD)** | **$265,459** | | |

As described in the Ecological Plan, approximately 500 acres will be targeted for vernal pool complex restoration in both the 2030 and 2070 climate scenarios. However, note that while 500 acres will be targeted, one of our sources stressed that typically a mitigation bank would only be approved for "perfected" credits for up to 10% of that land, hence the high cost of vernal pool credits. Therefore we assumed that only 50 acres worth of credits could be created.

The alternative costs of restoring 50 acres through conservation bank credit purchases were estimated over the project horizon of 84 years. According to the Ecological Plan, the 500 acres (i.e. 50 acres worth of credits) will be restored gradually between Years 1 and 10 of the project. Therefore, the alternative costs were adjusted in proportion to the number of acres restored in any given year and discounted appropriately. Each acre was only counted once over the project horizon, because a mitigation bank credit should represent a vernal pool habitat that has been restored in perpetuity.

**Monetization Results**

The worksheet "5B. Vernal Pool (Alt C)" in Attachment 6 shows the number of acres of vernal pool habitat restored at each year of the project, and links these areas to alternative cost estimates at each year. Alternative costs are expressed in present ($2015) dollars. A 3.5% discount rate is used to estimate the present value of future years. Table 9 shows the first 10 years of the alternative cost calculation as an example (note Attachment 6 includes the full 84 years).

**Table 9 - Vernal Pool Restoration Schedule and Alternative Costs**

| | 2030 Climate Scenario | | | | | |
|---|---|---|---|---|---|---|
| **Year** | **Vernal Pool COMPLEX acres** | **Additional Vernal Pool WETTED pools** | **Additional Vernal Pool Acres vs. Previous Year** | **Alternative Cost ($ per acre)** | **Total Alternative Costs by Year (undiscounted)** | **Total Alternative Costs by Year (discounted at 3.5%)** |
| 1 | 5 | 0.5 | 0.5 | $265,459 | $132,730 | $128,241 |
| 2 | 25 | 2.5 | 2 | $265,459 | $530,918 | $495,618 |
| 3 | 50 | 5 | 2.5 | $265,459 | $663,648 | $598,573 |
| 4 | 100 | 10 | 5 | $265,459 | $1,327,296 | $1,156,662 |
| 5 | 150 | 15 | 5 | $265,459 | $1,327,296 | $1,117,548 |
| 6 | 200 | 20 | 5 | $265,459 | $1,327,296 | $1,079,756 |
| 7 | 250 | 25 | 5 | $265,459 | $1,327,296 | $1,043,243 |
| 8 | 300 | 30 | 5 | $265,459 | $1,327,296 | $1,007,964 |
| 9 | 400 | 40 | 10 | $265,459 | $2,654,592 | $1,947,757 |
| 10 | 500 | 50 | 10 | $265,459 | $2,654,592 | $1,881,891 |
| Etc… | | | | | | |

### Net Present Value of Benefits

- 2030 climate scenario: $10,457,252
- 2070 climate scenario: $10,457,252

### Assumptions and Limitations

- It is assumed that a feasible and reasonable alternative to the state for vernal pool habitat restoration is the purchase of conservation bank credits for vernal pools and their associated species (e.g. vernal pool fairy shrimp).

- The alternative cost of restoring vernal pool habitat can be estimated using more than one approach. Another approach considered (but not used) was to estimate the alternative cost of vernal pools habitat restoration as stated in a recovery plan. In 2005, the U.S. Fish and Wildlife Service published a report that total estimated (known) cost of recovering vernal pool habitats in California and Southern Oregon through 2064 would be approximately $2 billion.[xv] However, it was not possible to break this total cost into per-acre costs.

### 5C. Willingness to Pay for Vernal Pool Habitat Improvement

This method was not used. We could not find any appropriate WTP studies or surveys in the literature that provide estimates for Californians' WTP for vernal pool habitat. While WTP studies do exist for wetlands in general (and these were used to value wetlands in Section 2C), we believe that vernal pools are too unique and rare to be appropriately valued using these studies.

## 6. Recreational Purposes

### 6A. Avoided Cost for Recreational Purposes

This method was not used. We could not identify any local or regional costs that would be avoided as a result of improvements in recreational purposes. For example, we could not identify any plans for recreational areas of facilities that would no longer need to be purchased.

### 6B. Alternative Cost for Recreational Purposes

This method was not used. The values for recreation are tied to the specific ecological values of this particular location. As those values are geographically fixed because of the ecology of the crane the recreation alternatives are also fixed. While non-crane recreation opportunities are also available as alternates, it was not considered reasonable to change the program purposes for that analysis. We could not identify any feasible alternatives that would achieve the same recreational outcomes. Because the recreation value is based on flow, and there is no available flow to purchase in the Cosumnes River, we believe this would not be a feasible alternative.

### 6C. Willingness to Pay for Recreational Purposes

**Benefit Type**

Public

**Benefit Category**

Recreational Purposes

**Physical Benefit**

Increased visitation due to increased river flows

**Physical Benefit (detail)**

Physical benefits are defined as the "positive or beneficial physical changes" associated with a project or action (California Code of Regulations, 2016). The physical benefit monetized in this section is the increased number of visitors to the river as a result of increased flow in the Cosumnes River.

**Applicable Ecosystem Priorities**

- P 9. Enhance flow regimes or groundwater conditions to improve the quantity and quality of riparian and floodplain habitats for aquatic and terrestrial species.
- P 11. Enhance the temporal and spatial distribution and diversity of habitats to support all life stages of fish and wildlife species.
- P 14. Provide water to enhance seasonal wetlands, permanent wetlands, and riparian habitat for aquatic and terrestrial species on State and Federal wildlife refuges and on other public and private lands.
- P 16. Enhance habitat for native species that have commercial, recreational, scientific, or educational uses.

**Monetization Method**

Willingness to pay

**Discount Rate**

3.5%

**Planning Horizon**

84 years

**Monetization Method (detail)**

We used the Benefit Transfer method to estimate the value of recreation improvements that would occur as a result of the project. We used a study by Loomis and Creel (1992), which estimates recreation benefits due to increased flows to the San Joaquin and Stanislaus Rivers.[xvi] The total benefits of such flows, which depended on the increase in willingness to pay (WTP) of recreation users as well as increased visitation as the result of increased flows, amounted to $45 to $116 per acre foot of water for the San Joaquin River and $11 to $13 per acre foot of water for the Stanislaus River, in 1989 USD.

We considered the change in river flow and visitation patterns in our project area with that of Loomis and Creel (1992). The average annual discharge of the Stanislaus River is approximately 700,000 acre-feet[xvii], and is approximately 7 million acre-feet[xviii] for the San Joaquin River. The average annual discharge of the Cosumnes River is approximately 600,000 acre-feet. Therefore we chose to use the values for the Stanislaus River, as the rivers are of similar flow rates, and the increase in flow rate from this project to the one described in Loomis and Creel (1992) is very similar. However, recreation visitation for the Stanislaus River in the study is unknown. Visitation to the Cosumnes River Preserve is approximately 70,000 visitors annually.[xix] As a smaller river, we assume the visitation of the Stanislaus River is similar or at least comparable. We also chose to use the value associated with the latest timing pattern in the year. Our reason for this choice is that the Regional San project will see river flow increases in the fall, which will mostly benefit fall-run Chinook. The value associated with flow pattern increases in August most closely matches this profile. The WTP value we chose for this benefit is $13.45 per additional acre foot of flow (or $26.24 in 2015 USD).

**Monetization Results**

The increased water volume the project will add to the Cosumnes River is estimated as the physical benefit. The WTP per acre-foot is multiplied by the additional flow volume in each year of the project horizon (which varies by year) for each climate scenario. The worksheet "6C. Recreation (WTP)" in Attachment 6 shows increased flow of the Cosumnes at each year of the project in the With-Project condition, and links these volumes to a WTP for each year.

WTP values are expressed in present ($2015) dollars. A 3.5% discount rate is used to estimate the present value of future years. The Net Present Value of benefits was then summed for Years 1-84 of the project.

**Net Present Value of Benefits**

- 2030 climate scenario: $9,485,088
- 2070 climate scenario: $7,608,544

**Assumptions and Limitations**

- It is assumed that recreation visitation along the Cosumnes River resembles that of the Stanislaus River.

# 7. Public Benefit: Water Quality Improvement

## 7A. Avoided Cost for Water Quality Improvement

This method was not used. This program in some regards is providing the avoided costs for other dischargers regulated under the Clean Water Act. We could not identify any local or regional costs other than this program that would be avoided as a result of improvements in water quality. This analysis is documented in the Technical Memorandum by developed by LWA.[xx]

## 7B. Alternative Cost for Water Quality Improvement

**Benefit Type**

Public

**Benefit Category**

Water Quality

**Physical Benefit**

Improved Water Quality in Surface Water Bodies, by Reverse Osmosis of Surface Water

**Physical Benefit (detail)**

Reduced salinity in Regional San's discharge has been demonstrated through modeling to have a quantifiable reduction in downstream salinity at monitoring locations such as Hood, Emmaton, Rock Slough, Old River, Clifton Court Forebay and the Delta Mendota Canal Headworks. Future with project estimated ambient EC levels (a measure of salinity) are modeled to be slightly lower than without project conditions in both 2030 and 2070 climate change conditions. This salinity reduction can assist downstream beneficial uses to be met. In order to reduce the salinity levels in Regional San's discharge on a mass loading basis, equivalent to the mass loading reduction associated with this South County project (95 tons/day), a technically feasible method that is proven as reliable in the industry is to use reverse osmosis treatment of a portion of the Regional San flow, removing almost 100% of the salt from that flow stream, and producing a brine stream that must be disposed of in an environmentally safe and permittable manner. For inland dischargers such as Regional San, this would most likely be done via thermal brine concentration, crystallization and land disposal. The product water would be a valuable resource, and given that level of treatment, could be used by municipal water suppliers as a groundwater injection supply (currently permittable) or other future methods such a raw water feed source into a Surface Water Treatment plant, once regulations dictating this level of potable reuse are promulgated (currently under development by Department of Drinking Water at the State Water Resources Control Board). The net cost of this salinity removal could be reduced by the revenue from the highly treated water supply (Larry Walker Associates, 2017)[xx].

**Applicable Water Quality Priority**

Priority 5: Salinity

**Monetization Method**

Alternative Cost. As documented in the Technical Memorandum by LWA, no other alternative cost or willingness to pay methodology was found to be available to better estimate the water quality benefits than this alternative cost methodology.

**Discount Rate**

3.5%

**Planning Horizon**

84 years

**Monetization Method (detail)**

To estimate the cost of the alternative treatment to the mass loading reduction of salinity associated with the project, Larry Walker Associates in its Technical Memorandum (referenced in Worksheet 3.4 in Attachment A.10), estimated capital costs at $284 M, annual O&M costs at $28.0 M/year, producing an annual cost of $38.6 M/year. Offsetting that cost with revenue at $400/AF for the 42,000 AFY of product water (20% of the water treated would be rejected as brine and evaporated), of $16.8 M/year, the net cost would be $21.8 M/year.

**Monetization Results**

The Worksheet " 3.4 Water Quality CvB" in Attachment A.10 shows the costs and offsetting revenues, in 2015 dollars, at a 3.5 % discount rate, over an 84-year project life, resulting in a net present value of the benefit, as shown below.

**Net Present Value of Alternative**

Net Present Value ($ 2015): $589,408,938

## 7C. Willingness to Pay for Water Quality Improvement

As documented in the Technical Memorandum by LWA, no willingness to pay methodology was found to be available to better estimate the water quality benefits than this alternative cost methodology.

## References or Data Sources Cited

[i] California Water Commission Division 7. 2016. California Code of Regulations Title 23: Waters.

[ii] California Water Commission Division 7. 2016. California Code of Regulations Title 23: Waters.

[iii] Layton, D., Brown, G., Plummer, M. 1999. Valuing Multiple Programs to Improve Fish Populations. Unpublished report prepared for the Washington Department of Ecology, Department of Economics, University of Washington. Seattle, WA.

[iv] Hanemann, M., Loomis, J., Kanninen, B. 1991. Statistical Efficiency of Double-Bounded Dichotomous Choice Contingent Valuation. American Journal of Agricultural Economics 73(4): 1255-1263.

[v] Moore SB, Winckel J, Detwiler SJ, Klasing SA, Gaul PA, Kanim NR, Kesser BE, DeBevec AB, Beardsley K, Puckett LK. 1990. Fish and Wildlife Resources and Agricultural Drainage in the San Joaquin Valley, California: San Joaquin Valley Drainage Program, Sacramento, California.

[vi] State of California Department of Finance. E-8 Historical Population and Housing Estimates for Cities, Counties, and the State.

[vii] Ivey, G., Duger, B., Herziger, C., Casazza, M., Fleskes, J. 2015. Wintering ecology of sympatric subspecies of Sandhill Crane: Correlations between body size, site fidelity, and movement patterns. Condor. Volume 117, 2015, pp. 518–529

[viii] Ivey, G., Duger, B., Herziger, C., Casazza, M., Fleskes, J. 2014. Distribution, Abundance, and Migration Timing of Greater and Lesser Sandhill Cranes Wintering in the Sacramento-San Joaquin River Delta region of California. Proceedings of the North American Crane Workshop 12: 1-11.

[ix] Richardson, L., Loomis, J. 2009. The total economic value of threatened, endangered and rare species: An updated meta-analysis. Ecological Economics 68: 1535-1548.

[x] State of California Department of Finance. Projections. Retrieved on 8/7/17 from: http://www.dof.ca.gov/Forecasting/Demographics/Projections/

[xi] U.S. Fish & Wildlife Service, 2011. Birding in the United States: A Demographic and Economic Analysis. Addendum to the 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation. Report 2011-1. Retrieved on 8/7/17 from: https://www.fws.gov/birds/bird-enthusiasts/bird-watching/valuing-birds.php

[xii] State of California, July 2017. State & federally listed endangered & threatened animals of California. https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=109405&inline

[xiii] Brouwer, R. 2000. Environmental value transfer: state of the art and future prospects. Ecological Economics 32: 137-152.

[xiv] Richardson, L., Loomis, J., Kroeger, T., Casey, F. 2015. The role of benefit transfer in ecosystem service valuation. Ecological Economics 115: 51-58.

[xv] U.S. Fish and Wildlife Service. 2005. Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon. Available at: https://www.fws.gov/sacramento/es/recovery-planning/Vernal-Pool/es_recovery_vernal-pool-recovery.htm

[xvi] Loomis, J., Creel, M. 1992. Recreation Benefits of Increased Flows in California's San Joaquin and Stanislaus Rivers. Rivers 3(1): 1-13.

[xvii] USGS Gage #11303000 Stanislaus River at Ripon, CA: Peak Streamflow. National Water Information System. U.S. Geological Survey. 1938–2015. Retrieved 2017-03-08.

[xviii] Benke, A., Cushing, C. 2006. Rivers of North America. Elsevier.

[xix] University of the Pacific. 2012. The Dangermond Ground, Economic & Planning Systems, Inc., Sapper West, Inc., Garcia DeCredico Studio, Peterson Brustad, Inc. Economic Sustainability Plan for the Sacramento-San Joaquin Delta. Delta Protection Commission.

[XX] Larry Walker Associates. 2017. Larry Walker Associates. 2017. Far-Field Water Quality Analysis and Benefit Monetization in Support of WSIP Application for South County Ag Program. August. GRANTS Physical Public Benefits tab, A.2 Water Quality Benefits Supporting Documents. File: "Regional San_WQ Salinity TM_A.1 WQ Benefit-Quantification_SecPPB.pdf"